Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

3420UA0-1

S25-3420UA0-1

MONDAY, 16 JUNE 2025 – MORNING

PHYSICS – Unit 1:
Electricity, Energy and Waves
HIGHER TIER

1 hour 45 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**11**	
2.	**9**	
3.	**5**	
4.	**6**	
5.	**11**	
6.	**16**	
7.	**6**	
8.	**10**	
9.	**6**	
Total	**80**	

3420UA01
01

ADDITIONAL MATERIALS

In addition to this paper you will require a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended response (QER) will take place in question **4**.

VP/GJR*(S20-3420UA0-1)

Equations

current = $\dfrac{\text{voltage}}{\text{resistance}}$	$I = \dfrac{V}{R}$
total resistance in a series circuit	$R = R_1 + R_2$
total resistance in a parallel circuit	$\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$
energy transferred = power × time	$E = Pt$
power = voltage × current	$P = VI$
power = current^2 × resistance	$P = I^2R$
% efficiency = $\dfrac{\text{energy [or power] usefully transferred}}{\text{total energy [or power] supplied}}$ × 100	
density = $\dfrac{\text{mass}}{\text{volume}}$	$\rho = \dfrac{m}{V}$
units used (kWh) = power (kW) × time (h) cost = units used × cost per unit	
wave speed = wavelength × frequency	$v = \lambda f$
speed = $\dfrac{\text{distance}}{\text{time}}$	
pressure = $\dfrac{\text{force}}{\text{area}}$	$p = \dfrac{F}{A}$
p = pressure V = volume T = kelvin temperature	$\dfrac{pV}{T}$ = constant
	T / K = θ / °C + 273
change in thermal energy = mass × specific heat capacity × change in temperature	$\Delta Q = mc\Delta\theta$
thermal energy for a change of state = mass × specific latent heat	$Q = mL$
force on a conductor (at right angles to a magnetic field) carrying a current = magnetic field strength × current × length	$F = BIl$
V_1 = voltage across the primary coil V_2 = voltage across the secondary coil N_1 = number of turns on the primary coil N_2 = number of turns on the secondary coil	$\dfrac{V_1}{V_2} = \dfrac{N_1}{N_2}$

SI multipliers

Prefix	Symbol	Conversion factor	Multiplier
pico	p	divide by 1 000 000 000 000	1×10^{-12}
nano	n	divide by 1 000 000 000	1×10^{-9}
micro	μ	divide by 1 000 000	1×10^{-6}
milli	m	divide by 1000	1×10^{-3}
centi	c	divide by 100	1×10^{-2}

kilo	k	multiply by 1000	1×10^{3}
mega	M	multiply by 1 000 000	1×10^{6}
giga	G	multiply by 1 000 000 000	1×10^{9}
tera	T	multiply by 1 000 000 000 000	1×10^{12}

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

Examiner only

Answer **all** questions.

1. In the UK, domestic electricity has a voltage of 230 V and a frequency of 50 Hz. It is an alternating current (a.c.) supply, rather than a direct current (d.c.) supply.

(a) State the difference between a.c. and d.c. [1]

....

....

(b) A science class investigates the cost and efficiency of different kettles. They collect and compare data for two different kettles.

	Kettle **X**	Kettle **Y**
Power	2200 W	2.4 kW
Time to boil (s)	90	90
Mass of water (kg)	0.6	0.6
Heat energy transferred to the water (J)	188 100	

(i) Not all of the heat energy transferred by the kettle is transferred to the water.

I. Use data from the table and an equation from page 2 to calculate the total electrical energy transferred by kettle **X** when it is boiled **once**. [2]

total electrical energy transferred by kettle **X** = ... J

II. Use data from the table, an equation from page 2 and your answer to part (i)I to determine the % efficiency of kettle **X**. [2]

% efficiency = ...

Examiner only

(ii) The students compare the cost of using each of the kettles.
They estimate that each kettle will be boiled 10 times per day.

I. Calculate the time that each kettle is used per day in hours. [1]

time = ... hours

II. Use equations from page 2 to calculate the cost of using kettle **Y** per day if 1 unit of electricity costs 30 p. [3]

cost per day = ... p

(iii) It is suggested that kettle **X** will cost more to use per day, than kettle **Y**, when used for the same time.
Explain whether you agree with this suggestion. [2]

....

....

....

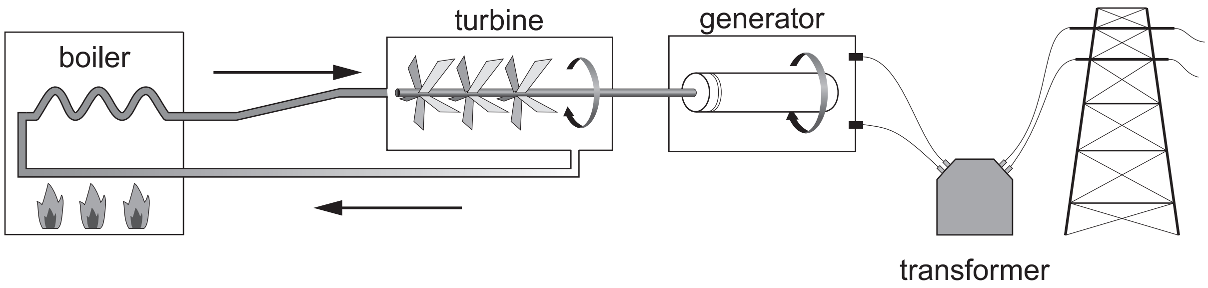
11

3420UA01
05

Examiner only

2. Drax power station is a fuel-burning power station.
In 1986, Drax was the largest power station in the UK.
It consisted of 6 coal-fired generators with a total capacity of about 4000 MW, powering millions of homes.
By 2018, Drax had converted four of the coal-fired generators to run on biomass, producing 70% of its electrical power through burning compressed wood pellets.

(a) The simplified diagram below shows a fuel-burning power station.



Describe the processes involved in producing electrical power from a fuel. [3]

....

....

....

....

....

....

....

(b) Burning biomass does not produce sulfur dioxide.
State **and** explain another environmental advantage of burning biomass rather than coal. [2]

....

....

....

....

Examiner only

(c) The demand for electricity depends on the weather.
In the winter, demand increases by 750 MW for every degree the temperature drops below 14 °C.
In the summer, demand increases by 350 MW for every degree rise over 20 °C, from a mean demand of 40 000 MW.

(i) Suggest why demand for electricity increases as the temperature increases above 20 °C in the summer. [1]

....

....

(ii) On one summer's day, the demand for electricity increased to 45 600 MW.
Chris suggests that the temperature must have risen to 30°C, but Ella states that it must be 36 °C.
Determine who is correct. [3]
Space for calculations.

....

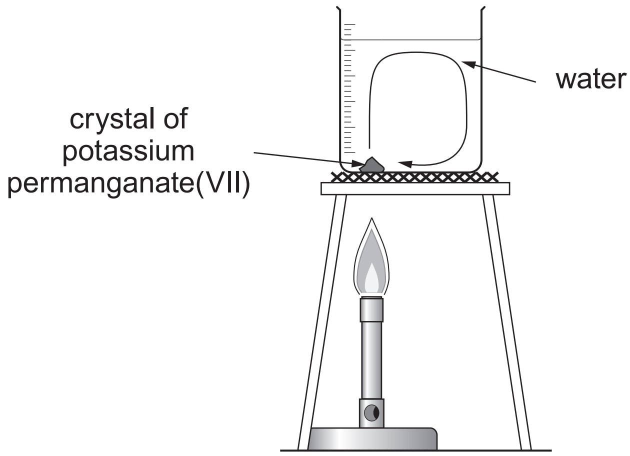
....

3420UA01
07

9

Examiner only

3. The apparatus below can be used to demonstrate heat transfer in water.



(a) Name the heat transfer process being demonstrated. [1]

....

(b) (i) Describe what happens to the water particles when the water is heated. [2]

....

....

....

(ii) Explain, in terms of density, why the water moves in the direction shown by the arrow when it is heated. [2]

....

....

....

5

Examiner only

4. Describe the properties of P and S waves **and** explain how a model of the structure of the Earth has been produced from seismic records. [6 QER]

....

....

....

....

....

....

....

....

....

....

....

....

....

....

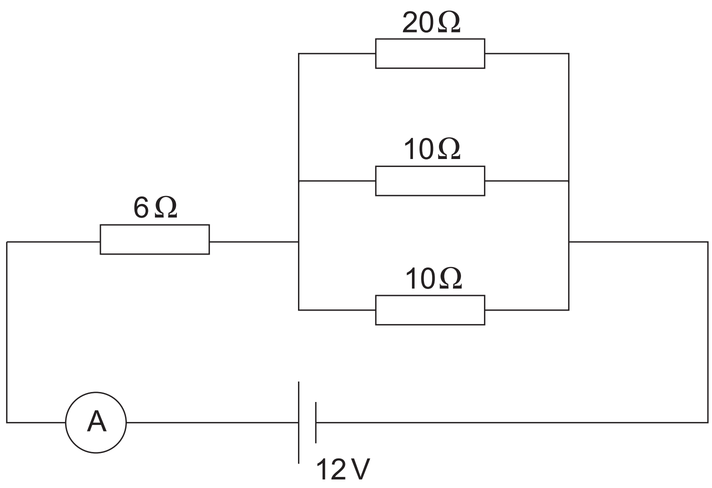
....

3420UA01 09

6

Examiner only

5. A class investigates series and parallel circuits and sets up the following circuit.



(a) Use the equation:

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

to determine the resistance of the **parallel** combination. [3]

resistance = ... Ω

(b) Use an equation from page 2 to calculate the total resistance of the circuit. [1]

total resistance = ... Ω

 (3420UA0-1)

Examiner only

(c) Use an equation from page 2 to calculate the current measured by the ammeter. [2]

current = ... A

(d) Use an equation from page 2 to calculate the voltage across the 6 Ω resistor. [3]

voltage = ... V

(e) Explain how you could use your answer to part (d) to determine the current through the 20 Ω resistor. [2]
Calculations are not required.

....

....

....

....

3420UA01
11

11

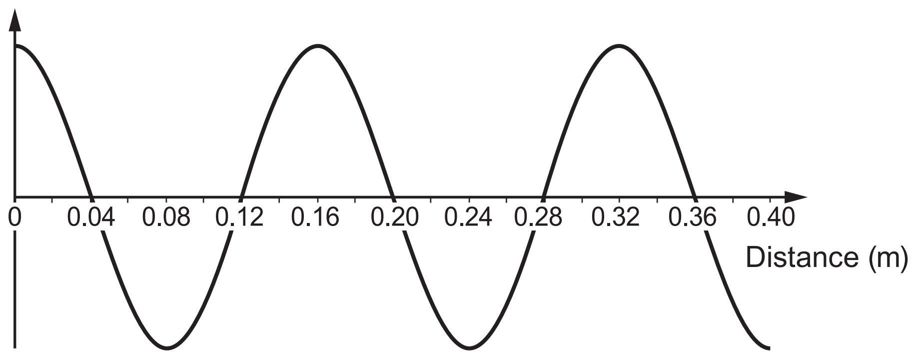
BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

Examiner only

6. (a) **Diagram 1** represents an electromagnetic (em) wave.

Diagram 1

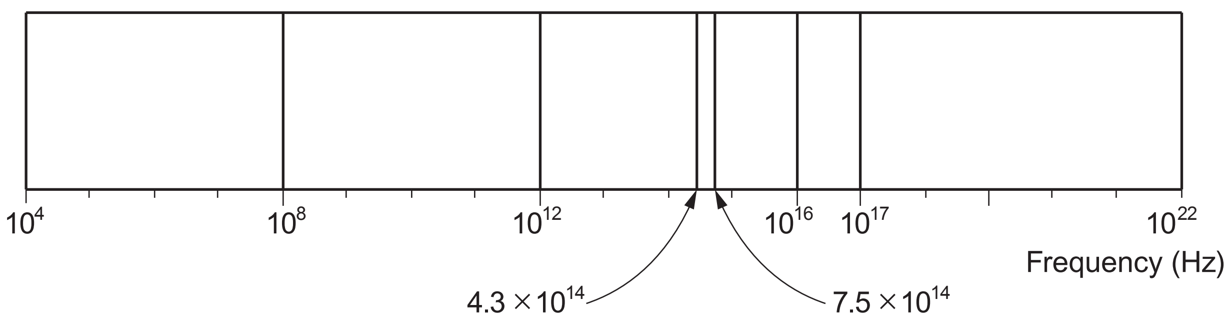


Use the diagram and an equation from page 2 to determine the frequency of the wave.
The speed of light, $c = 3.0 \times 10^8$ m/s. [3]

frequency = ... Hz

(b) **Diagram 2** is an unlabelled diagram of the em spectrum.
It shows typical frequencies of the different regions of the spectrum.
An em wave has a frequency of 2×10^{15} Hz.
Determine what type of em radiation it is. [1]

Diagram 2



type of radiation = ...

Turn over.

Examiner only

(c) Most waves can be described as either transverse or longitudinal.
Describe the difference between transverse and longitudinal waves. [2]

....

....

....

(d) Students study the motion of water waves in the laboratory, investigating how the speed of water waves is affected by the depth of the water.
They time how long waves take to travel 120 cm, which is **three lengths** of a tray.

(i) Explain why the students time the waves for three lengths rather than one length. [2]

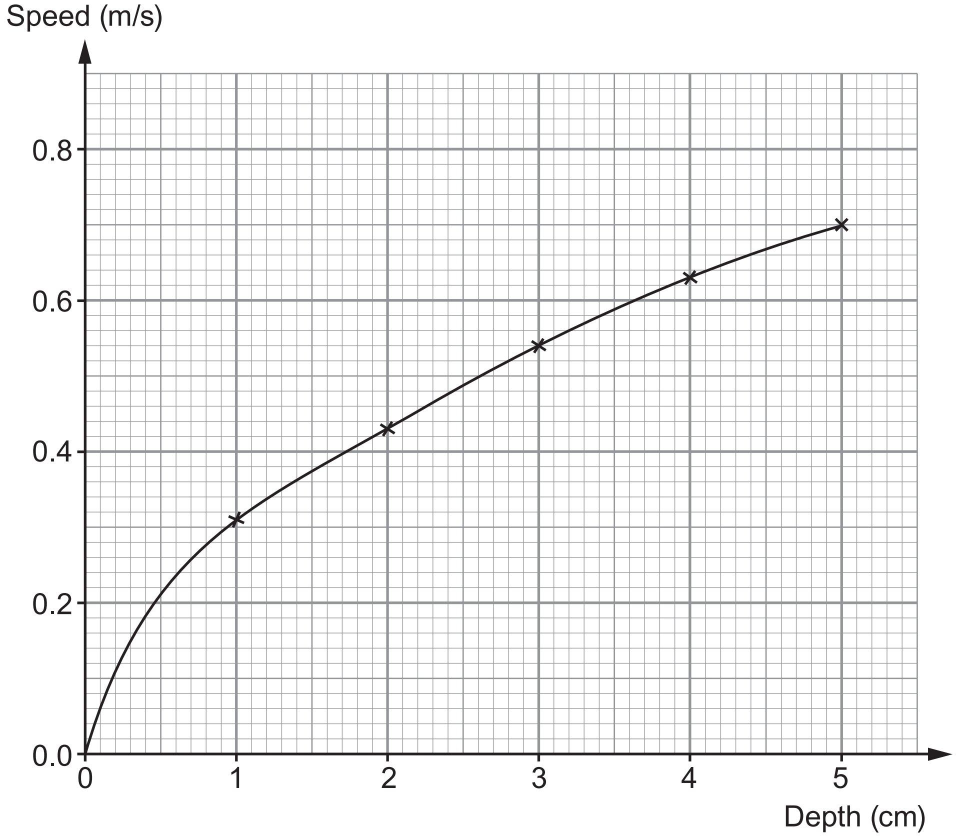
....

....

....

....

(ii) A graph of their results is shown below.



Examiner only

I. Use the graph and an equation from page 2 to determine the time taken for the waves to travel **one length** of the tray at a depth of 2.5 cm. [4]

time = ... s

II. It is suggested that doubling the depth from 1 cm to 2 cm increases the speed by a factor of 4.
Determine whether this suggestion is correct. [2]
Space for calculations.

....

....

(iii) The equation:

$$\text{speed} = \sqrt{10 \times \text{depth of water (m)}}$$

can be used to determine the true speed of the water waves.
Comment on the accuracy of the data for a depth of 2.5 cm (0.025 m). [2]
Space for calculations.

....

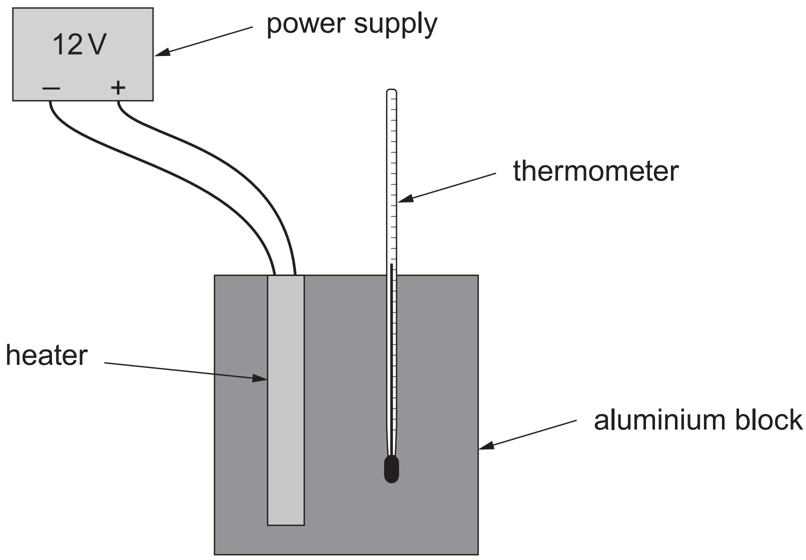
....

....

....

16

7. Students carry out an experiment to determine the specific heat capacity of aluminium in the form of a block.



They collect the following data:

Initial temperature of block (°C)	21
Final temperature of block (°C)	36
Mass of aluminium block (g)	980
Density of aluminium (kg/m^3)	2700
Heat energy transferred by the heater (J)	14 650

Examiner only

(a) Only 90% of the heat energy transferred by the heater causes the block's temperature to rise.
The rest is transferred to the surroundings.

(i) Determine the heat energy transferred to the aluminium block. [1]

heat energy transferred = ... J

(ii) Use an equation from page 2 to calculate the specific heat capacity, c, of aluminium. [3]

specific heat capacity, c = ... J/kg °C

(b) The students repeat their experiment with a steel block.
Gwilym states that if the block has the same mass as the aluminium block, it must have the same volume.
Explain whether you agree. [2]

....

....

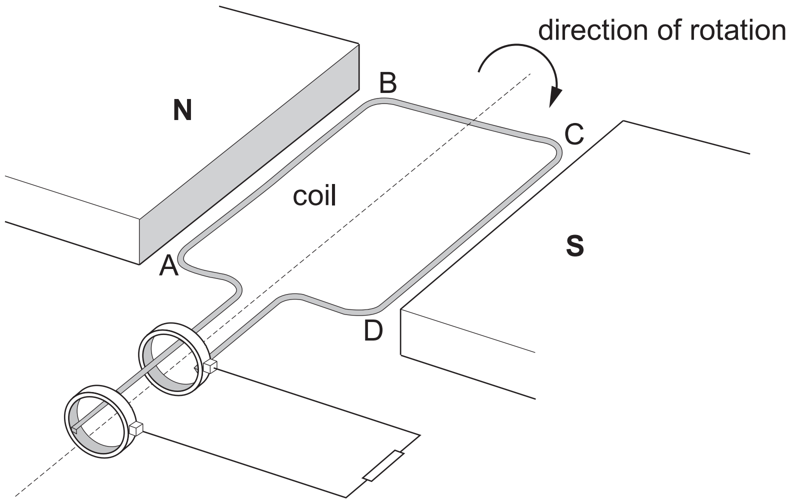
....

....

6

Examiner only

8. The diagram shows a simple a.c. generator.
When the coil is in the position shown, the current produced by the generator is a maximum.



(a) (i) Explain why a current is produced in the coil as it rotates. [2]

....

....

....

(ii) I. Determine the direction of the current in side AB of the coil when it is in the position shown in the diagram. [1]

....

II. Explain how you did this. [1]

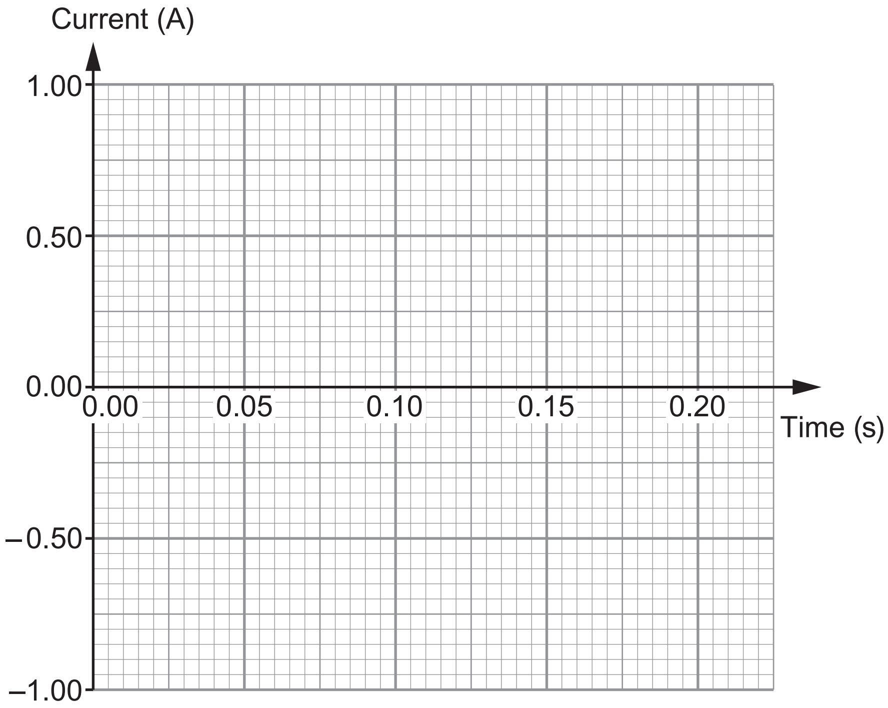
....

....

....

Examiner only

(b) (i) The coil rotates **from the position shown** in the diagram opposite.
Each complete rotation takes 0.20 s.
The maximum current is 0.75 A.
Sketch a graph of current against time on the axes below. [3]



(ii) Describe the effect on the output current from the generator if the magnetic field strength is increased **and** the coil spins more slowly. [3]

....

....

....

....

....

10

Examiner only

9. A radiosonde is a small package of instruments which is carried into the atmosphere by a helium-filled balloon.
The instruments are used to collect data for weather forecasting.
The balloon moves up through the atmosphere until the helium has such a large volume that the balloon bursts.
The instruments then return to Earth with a parachute.

(a) On a winter day, the balloon is filled with helium inside a warm room.
It is then taken outside, where it is much colder and the volume decreases.
Explain, in terms of particles, why this happens. [3]

....

....

....

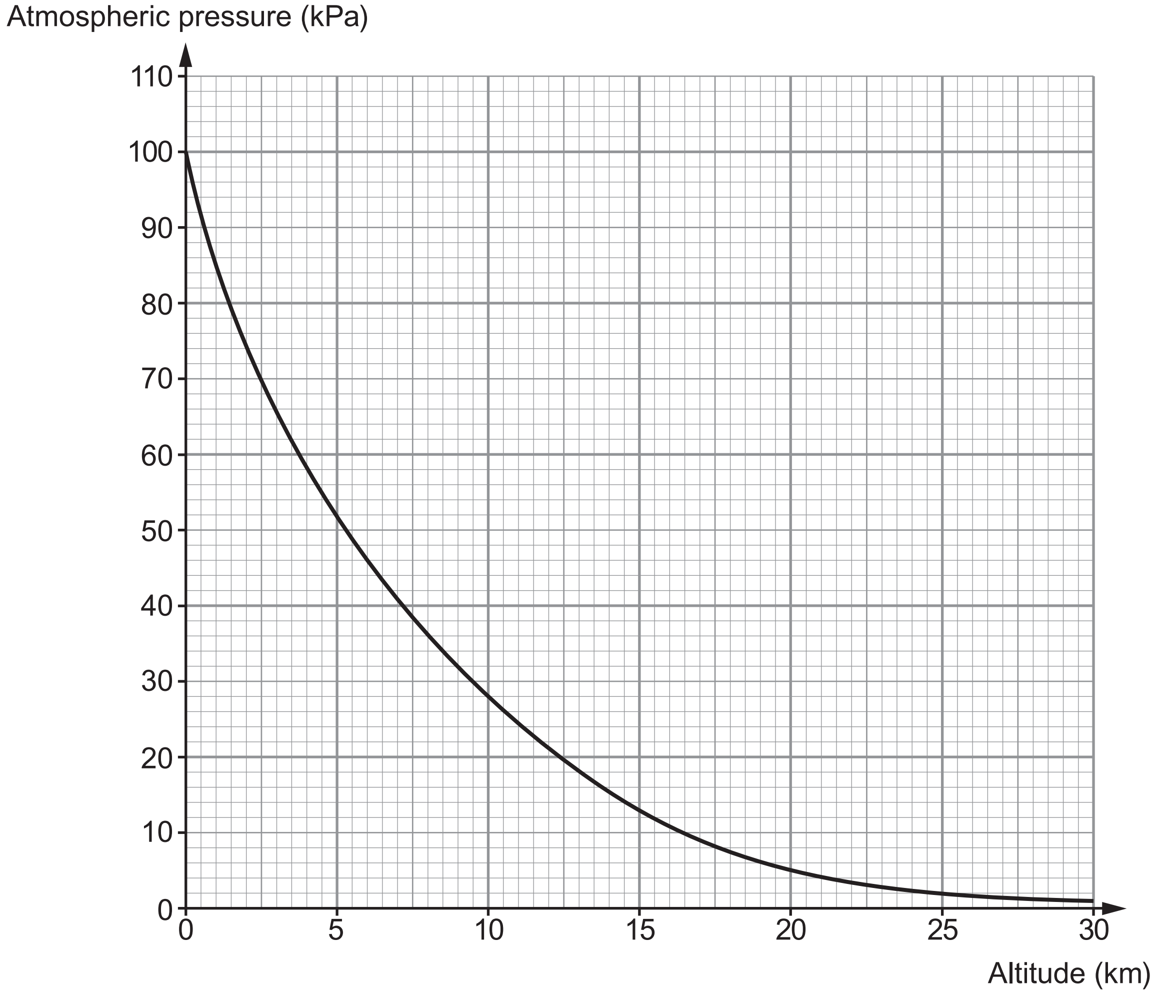
....

....

....

Examiner only

(b) The atmospheric pressure is not constant and decreases as the height above the sea level (altitude) increases as shown by the graph below.



The temperature at sea level is 278 K.
The balloon has an initial volume of 1.8 m^3 at sea level.
The balloon bursts when its volume reaches 133 m^3 when the temperature is 212 K.

(i) Use the graph and the equation:

$$\frac{pV}{T} = \text{constant}$$

to determine the pressure at which the balloon bursts. [2]

pressure = ... kPa

(ii) Use the graph to determine at what altitude the balloon bursts. [1]

altitude = ... km

6

END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

Examiner only

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE